A strategy for Preparing Software Organizations for Statistical Process Control

as defined by

Monalessa Perini Barcellos, Ricardo de Almeida Falbo, Ana Regina Rocha, J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

In this part, the graphic notation is reused, as the original authors of the strategy proposed: the definition of a new concept is reported in **Bold** character, related instances are underlined.
Additionally, concept to be defined or redefined are reported in ***Bold Italic***.

SPC in Software organizations

At high maturity levels, such as CMMI levels 4 and 5, SPC occurs after a measurement program has been institutionalized (a requirement of CMMI level 2). As a result of the measurement program, measures and data are stored in an organizational ***measurement repository***.

It is expected that these measures and data are suitable to be used in ***SPC***. However, usually this is not the case.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

A Strategy to Measure for SPC

A **S**trategy is proposed by M. Perini Barcellos *and others*, **B**ra**z**il, (**BzSM**) to support organizations that desire to achieve high maturity levels to obtain and maintain measurement repositories suitable for SPC as well as to perform **M**easurements appropriately for this context.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

BzSM: Measurement related factors that negatively influence SPC implementation

N1. Inconsistent measurements

N2. Data grouping containing data from projects that are not similar

N3. Aggregate data that cannot be disaggregate

N4. Lost measurement data

N5. Deficient operational definition of measures

N6. Insufficient amount of collected data

N7. Insufficiency or absence of measurement context information

N8. Insufficiency or absence of measures that describe process performance

N9. Measures with inappropriate granularity level

N10. Insufficiency or absence of correlated measures

N11. Measures not aligned to organizational or project goals

N12. Measures incorrectly normalized

N13. Poorly structured measurement repository

N14. Data collection for a measure occurring in different moments in the projects, i.e., for each project, the same measure is collected in different moments

N15. Ambiguous measurement data

N16. Measurement data stored in different and not integrated sources

N17. Data collected for a measure with different granularity levels

N18. Measures related to too long processes (even if the granularity level is suitable, the measurement collection frequency is low)

N19. Use of traditional control measures instead of process performance measures

N20. Incorrect measurement data

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

BzSM: Measurement related factors that positively influence SPC implementation

P1. Centralized data storage

P2. Automatic data collection

P3. Definition of criteria for grouping data that considers the projects characteristics

P4. Existence and integrated use of process and product measures

P5. Existence of measures able to support decision making

P6. Identification of relationships between measures

P7. Existence of at least twenty collected data for measures that will be used in SPC

P8. Existence of measures related to activities able to produce tangible items

P9. Existence of measures related to critical processes

P10. Existence of measures related to all phases of projects process

P11. Definition of measures with clear and known intended use

P12. Existence of measures for project monitoring that can also be used to describe process performance

P13. Existence of measures that can be normalized and existence of the measures required for normalization, in order to allow comparisons

P14. Identification of homogeneous data groups

P15. Identification of the process or activity in which measures must be collected

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

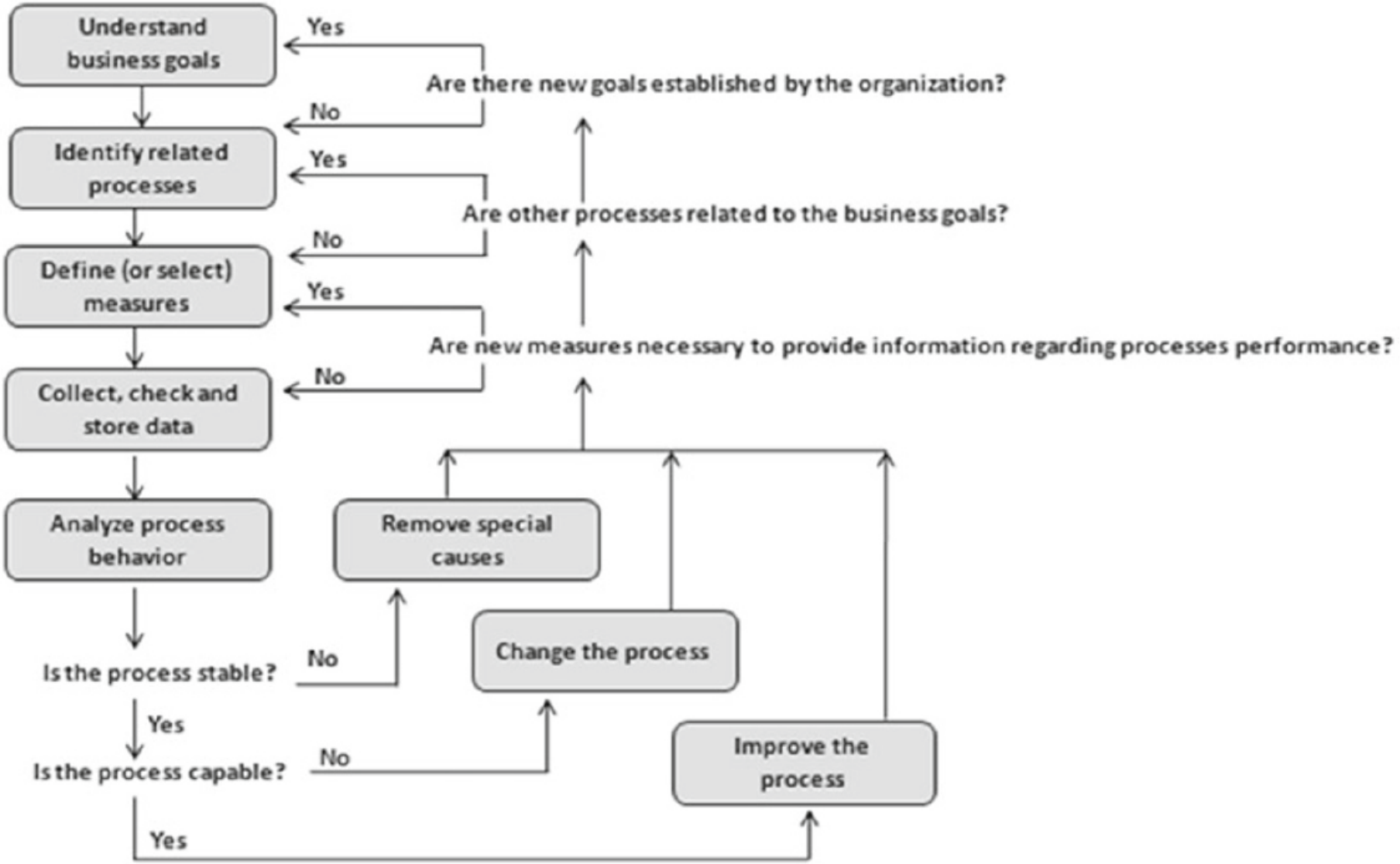
BzSM: **Components**

The proposed strategy has three components:

1. **RSMO**, which is a **R**eference **S**oftware **M**easurement **O**ntology
2. **IESMR**, which is an **I**nstrument for **E**valuating the **S**uitability of a **M**easurement **R**epository for SPC
3. **BRSM**, which is a **B**ody of **R**ecommendations for **S**oftware **M**easurement Suitable for SPC.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

The BzSM Process Behavior Analysis Model



M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

BzSM: **Scenarios**

Software organizations that are interested in using SPC are generally in one of two scenarios.

i. There are organizations that *have achieved* the initial maturity levels and *wish to use* the measures and data collected along those levels in SPC.

ii. There are organizations that *are starting* a SPI program and intend, since the initial levels, to build a measurement repository and perform measurement suitable for SPC.

The strategy proposed can be used in both scenarios.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

BzSM: **Reactive vs. Proactive Approaches**

Reactive approach . Organizations *have already* a measurement repository. They can use the IESMR component in order to *evaluate and adapt*, when possible, their measurement repositories for SPC.

Pro-active approach. Organizations are *starting SPI* programs. They can use the knowledge provided by the RSMO and the recommendations provided by the BRSM for *building* a measurement repository, elaborating a Measurement Plan and carrying out *measurements suitable* for SPC.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

BzSM: **Using Continuously the Strategy**

Since an organization starts SPC, new data will be collected and, probably, new measures will be defined. Therefore, the strategy can be used continuously, aiming *to maintain the suitability* of the measurement repository for SPC.

In other words, organizations can continuously use the RSMO and the BRSM as sources of knowledge for *defining* new measures and *carrying out* measurements, and they can also use the IESMR as a support for *evaluating* the measurement repository, when it is changed.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

RSMO

A Reference Software Ontology

as defined by

Monnalessa Perini Barcellos et al., from 2010, in 2013, et successive years.

Subontologies and Integrated Ontologies

BzSM RSMO

Some Stages of the Measurement Processes

The **software measurement process** includes, but is not limited to, the following activities:

- Planning the measurement process,
- Performing the measurement process, and
- Evaluating the measurement process.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al.*, 2010

Planning Measurement

Initially, an organization must **plan** measurement ["Measurement planning"].

Based on its ***goals***, the organization has to *define* which ***entities*** (processes, products and so on) are to be considered for software measurement and which of their ***properties*** ["attributes"] (size, cost, time, etc.) are to be measured.

The organization has also to define which ***measures*** ["Measurement models" | "Metrics"] are to be used to quantify those elements. For each measure, an ***operational definition*** should be specified, indicating, among others, *how* the measure must be collected and analyzed.

Once planned, measurement can *start*.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al.*, 2010

Performing Measurement

Measurement execution involves *collecting* ***data*** for the defined measures, according to their operational definitions.

Once data are collected, they should be *analyzed*, also following the ***guidelines*** established by the corresponding operational definitions.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al.*, 2010

Evaluating Measurement

Finally, the measurement process and its products should be *evaluated* in order to identify potential ***improvements***.

M. Perini Barcellos *et al*. J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al*., 2010

RSMO. **Measurement vs. Maturity Level**

At initial levels traditional measurement occurs, consisting basically in collecting data from projects and *comparing* them with their ***planned values***.

At high maturity levels, traditional measurement is not enough. It is necessary to carry out statistical process control in order to know the processes behavior, determine their performance in previous executions, and *predict* their ***performance*** in current and future projects, verifying if they are able to achieve the established goals.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al.*, 2010

RSMO. **Process Control**

SPC uses a set of statistical techniques to determine if a process is under control, considering the statistical point of view.

A **process** is **under control** if its behavior is stable, i.e., if their *variations are within the expected limits*, calculated from historical data. The behavior of a process is described by data collected for performance measures defined to the process.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al.*, 2010

RSMO. Stable Processes

A process under control is a **stable process** and, as such, has *repeatable behavior*. Consequently, it is possible to *predict* its ***performance*** in future executions and, thus, to *prepare* achievable plans and to *improve* the process continuously.

RSMO. Unstable Processes

A process that varies beyond the expected limits is an **unstable process** and the causes of these variations (said **special causes**) must be investigated and addressed by improvement actions, in order to stabilize the process.

M. Perini Barcellos *et al*. J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al*., 2010

RSMO. **Capable Processes**

Once the processes are stable, their ***levels of variation*** can be established and sustained, being possible to predict their results.

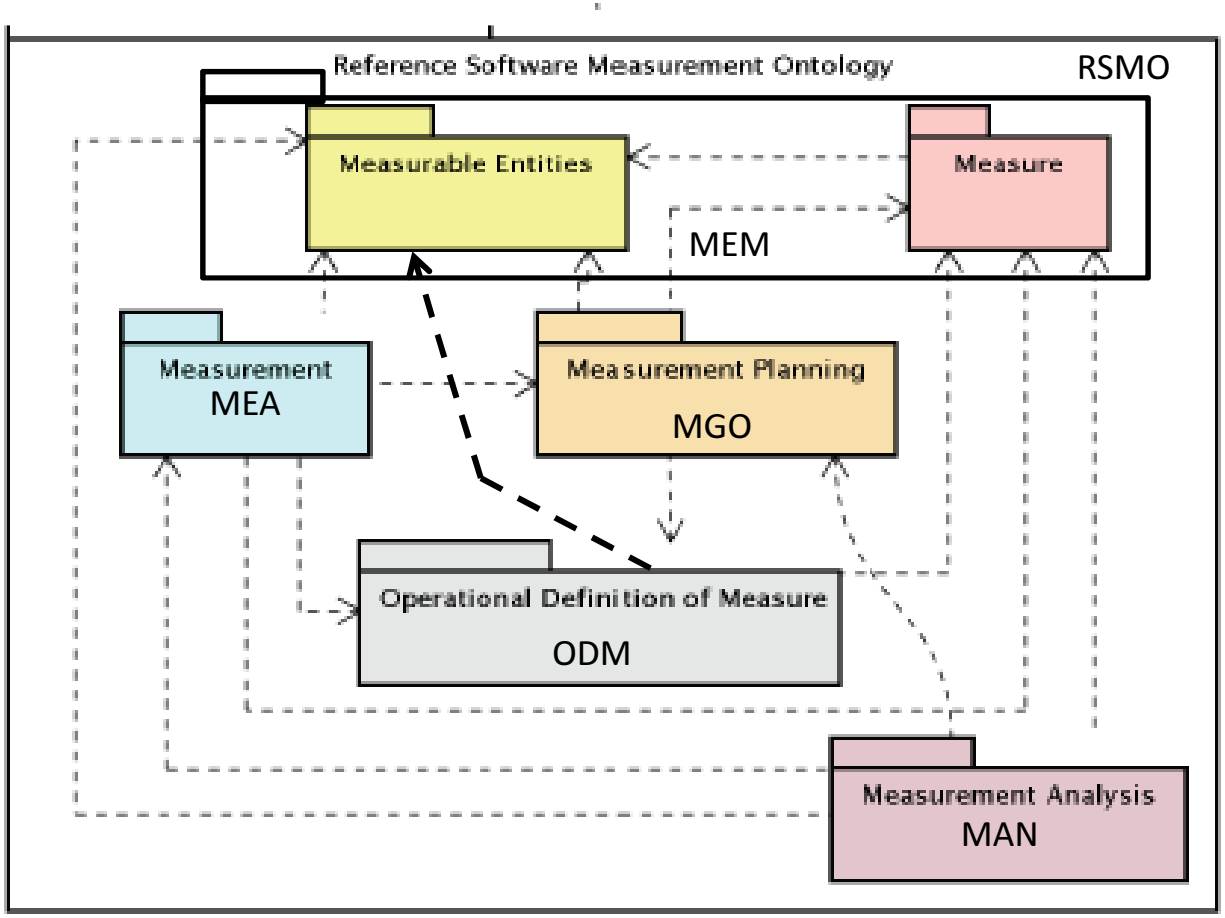
Thus, it is also possible to identify the processes that are **capable** of achieving the established goals and the processes that are failing in meeting the goals.

In this case, actions to change the process in order to make it capable should be carried out.

M. Perini Barcellos *et al*. J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al*., 2010

RSMO Sub-ontologies (2010)

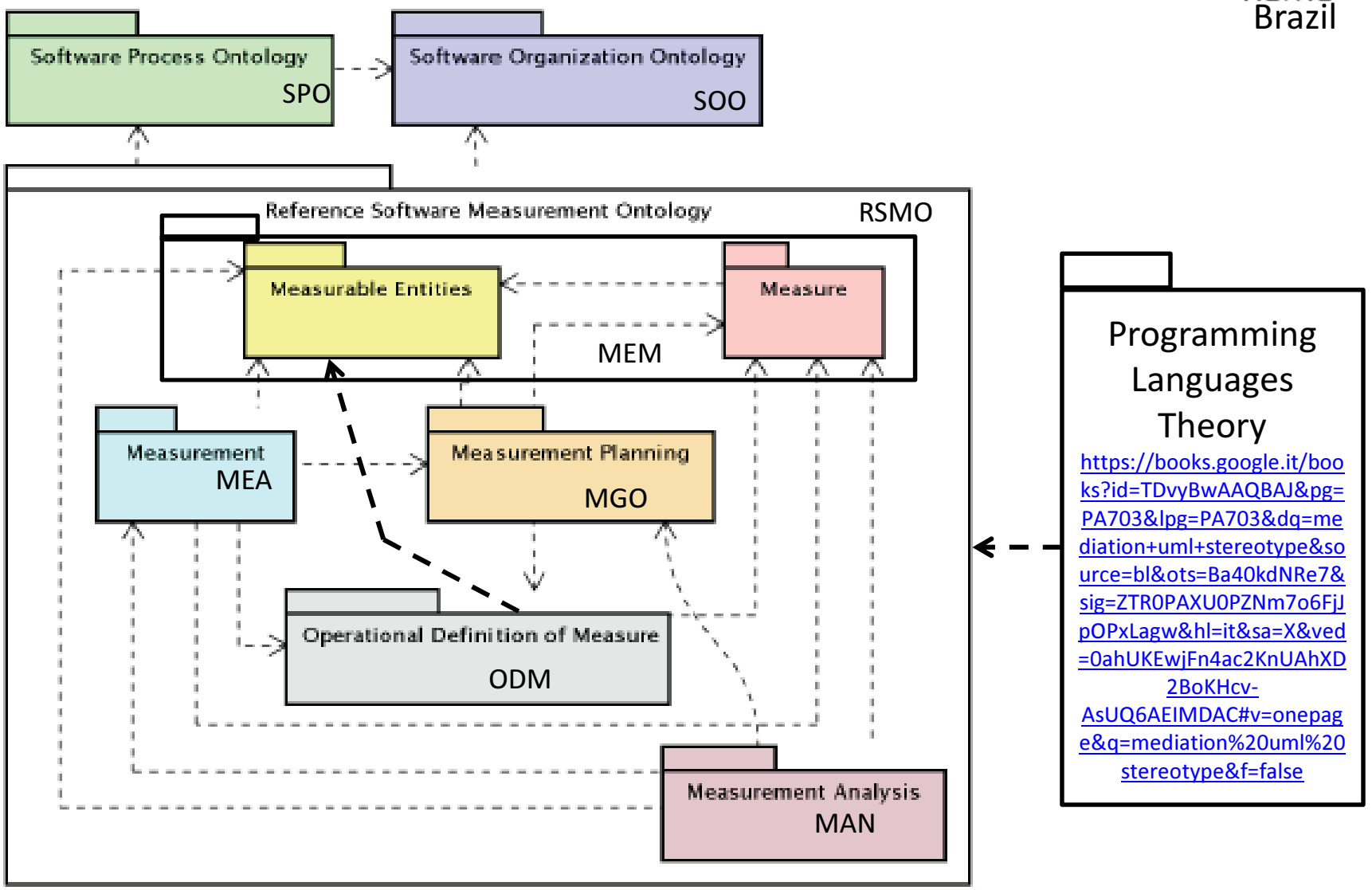
nemo Brazil



Monnalessa Perini Barcellos *et al.*, 2010

RSMO Sub-ontologies & Integrated Ontologies (2010)

nemo Brazil



Monnalessa Perini Barcellos *et al.*, 2010

RSMO's Sub-ontologies (2015)

RSMO includes – but is not limited to - the following sub-ontologies.

- The **Measurable Entities & Measures** (**MEM**) sub-ontology is the core of the RSMO. It treats the *entities* that can be submitted to measurement, their *properties* ["attributes"] that can be measured, and the *measures* ["measurement models"] used to measure them.
- The **Measurement Goals (MGO)** [formerly Measurement Planning] sub-ontology deals with the *alignment* of *measurement* to organizational *goals*.
- The [**Software**] **Measurement (MEA)** sub-ontology refers to the measurement per se, i.e., *collecting and storing data* for measures.
- The **Operational Definition of Measures (ODM)** sub-ontology addresses the detailed definition of operational aspects of measures, including *data collection* and *analysis* ["real-time data analysis"].
- The **Measurement** [**Results**] **Analysis (MAN)** sub-ontology deals with the *analysis of the collected data* for getting information to support decision making.
- The **Process Behavior Sub-ontology** (**PBE**) , which refers to applying the measurement results in the analysis of the behavior of the organizational software processes.

M. Perini Barcellos *et al.* J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x
M. Perini Barcellos *et al.*, 2010

Mapping between RSMO concepts and standard's terms

nemo Brazil

RSMO concept	ISO/IEC 15939	PSM	IEEE Std.1061	CMMI	MR MPS
Measurable Entity Type	–	–	–	–	–
Measurable Entity	Entity	Entity	Entity	–	Entity
Measurable Element	Attribute	Attribute	Attribute	–	Attribute
Directly Measurable Element	–	–	–	–	–
Indirectly Measurable Element	–	–	–	–	–
Measure	Measure	Measure	Metric	Measure	Measure
Base Measure	Base Measure	Base Measure	Direct Metric	Base Measure	Basic Measure
Derived Measure	Derived Measure	Derived Measure	Metric	Derived Measure	Derived Measure
Scale	Scale	Scale	–	Scale	Scale
Scale Type	Type of Scale	Type of Scale	–	–	–
Scale Value	–	–	–	–	–
Measure Unit	Unit of Measurement	Unit of Measurement	Unit of Measure	Unit of Measure	Unit of Measure
Measure Calculation Formula	Measurement Function	Measurement Function	–	–	Function

BMMO: Measurement Model '90s (MM)

BMMO: Indirect MM

BMMO: Direct MM

M. Perini Barcellos *et al.*J Braz Comput Soc (2013) 19:445–473 DOI 10.1007/s13173-013-0106-x

Monnalessa Perini Barcellos et al., 2010